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ANALYSIS OF MSW COMBUSTION TEMPERATURE IN A HOT WATER BOILER WITH THE LOW-CAPACITY

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Abstract. The paper analyzes the combustion temperature of solid waste in a small-capacity hot-water boiler with a great depending on the humidity of the solid waste, the excess air factor, the temperature of the air supplied to the combustion and the amount of heat taken and the range of parameters that provide the required combustion temperature is 900 ... 1100 °C, which provides complete destruction of organic waste substances in the waste, but does not lead to ash melt and the formation of sprays. It is concluded that the necessary temperatures are provided for a wide range of regime parameters and the humidity of solid waste. But selection of heat in the boiler leads to a significant decrease in the combustion temperature. Therefore, in boilers for burning low-power MSW, it is necessary to constructively separate the combustion zone and the heat extraction.

At present, there is no cost-effective and simultaneously environmentally safe solution for the disposal of solid domestic waste (MSW) [1, 2]. The existing system of waste management in Russia is focused mainly on their disposal at landfills. This leads to the withdrawal from the use of large land areas, pollution of the atmosphere by bio gas and toxic combustion products in self-ignition of waste, and soil and water bodies - a toxic liquid ("filtrate") formed in the waste layer [3].

Incineration of domestic garbage is the most common and widespread method of its utilization. There are about 1500 incineration plants in the world, of which about one third - in Europe, where about 16% of waste is burned, mainly with the generation of thermal energy and slightly - with the generation of electricity [4]. In the US, the volume of MSW burned after the 2000s was comparable to the amount of waste placed at landfills. Burning domestic waste, in addition to reducing the volume and weight, allows you to get additional energy resources that can be used for centralized heating and power generation. In addition, the storage of the remaining part of solid waste after burning is environmentally safe and requires 10 - 12 times less area.

There are three main methods for burning solid waste - layered (with a fixed and moving grate or chain grate); pulverized (in the suspended or boiling layer) and pyrolysis boilers. The first method is easier to implement, does not require preliminary preparation of debris, is highly reliable, but the second allows for more complete combustion of waste. According to the materials of a number of sources, pyrolysis is the most economically effective and has the least impact on the environment [6]. However, the opinions of specialists differ on the effectiveness of dry pyrolysis in the combustion of solid domestic and certain industrial wastes [7].

The main disadvantage of direct combustion is pollution of the atmosphere by harmful emissions with an excess of oxygen in the combustion zone and a low combustion temperature [8]. But for example, in work [7] it is stated that dumping of waste in landfills is more dangerous than processing by burning. The experience of Sweden shows that, despite the growth in the volume of domestic waste in recent years, the release of dioxins into the atmosphere from incineration plants is only 5-6% of all emissions, i.e. as much as in previous fires in landfills [4].

Thermal waste neutralization at the modern level of development of science and technology guarantees almost complete destruction of organic harmful substances in waste [8]. But for this it is necessary to ensure high temperatures. According to the Directive 2000/76 / EC of the European Parliament and of the



Council "On incineration of waste", installations in which the combustion products are at least 2 s at a temperature of at least 850 ° C or if dangerous waste containing more than 1% of halogen organic compounds expressed as chlorine, the temperature should be at least 1100 ° C.

But at temperatures above 1100 ° C, the ash produced by incineration of solid waste begins to melt, which leads to the formation of cakes [1], which clog the cells of the grate. Therefore, the temperature of combustion of solid waste should lie in the interval 850-1100 ° C.

The paper analyzes the combustion temperature of solid domestic waste in a hot-water boiler with a grate depending on the humidity of the solid waste, the excess air factor, the temperature of the air supplied to the combustion and the amount of heat taken and the range of parameters that provide the required combustion temperature is 900 ... 1100 ° For calculations, the composition of solid waste was used according to the data of [1, 9] (Table 1).

Table 1. MSW composition

MSW composition	Share	Characteristicsofperformance, %						
		A ^p	W ^p	C ^p	H ^p	O ^p	N ^p	S ^p
Foodwaste	0,3	3	76	11,26	1,62	7,16	0,84	0,13
Paper	0,3	12	2	39,73	5,33	40,51	0,26	0,17
Tree	0,05	1	67	16,32	1,95	13,63	0,06	0,03
Plastic	0,25	21	2	52,13	7,16	16,56	0,85	0,31
Noncombustiblepart	0,1	100	0	-	-	-	-	-
Working composition of solid waste		19,8	27,25	29,14	3,97	19,12	0,54	0,17

The calculation was carried out for a 200 kW boiler incinerated at Ltd TK Ekontras (Belgorod, Serafimovich Str., 72) and designed to generate hot water for heating the administrative and industrial building. This solid-fueled boiler represents an all-welded construction of steel with dimensions of 1230 m (width) x 1600 mm (depth x 2170 mm (height).) Fuel is burned on the grate, the air intake can be either natural or blowing fan. The walls of the boiler are warmly insulated with mineral wool Izovol ST-40, the thickness of insulation is 0.2 m.

The boiler's heat balance was calculated, which includes the following articles:

- the arrival of heat: a) from the combustion of fuel; b) physical heat of fuel; c) heat of air;
- heat consumption: a) the heat of the combustion products (CO₂, SO₂, H₂O, N₂, O₂); b) heat of ash;
- c) losses through the walls of the boiler; d) losses from under burning; e) heat sink (the amount of heat taken in the heat exchanger for heating water).

According to the obtained heat of combustion products, their temperature was determined, which was assumed equal to the actual combustion temperature.

In Fig. 1 shows the dependence of the combustion temperature on the coefficient of excess air and humidity of solid waste at different temperatures of air supplied for combustion and the absence of heat in the boiler. In Fig. 2, from the data obtained, isotherms are constructed that determine the region of required temperatures. According to the graphs, MSW can be burned at a humidity of up to 20-30 without preheating the combustion air. Higher humidity of solid waste requires the use of preheating of air, which can be carried out due to the heat of the combustion products.

Unlike large-capacity boilers, where the combustion and heat dissipation zones are spatially separated, in boilers of small production, heat extraction takes place directly in the combustion chamber, which leads to a decrease in the combustion temperature. The calculation of the combustion temperature in the presence of heat removal in the boiler showed , that even an insignificant part of the heat, taken in the furnace, leads to the impossibility of obtaining the required temperatures (Fig. 3).

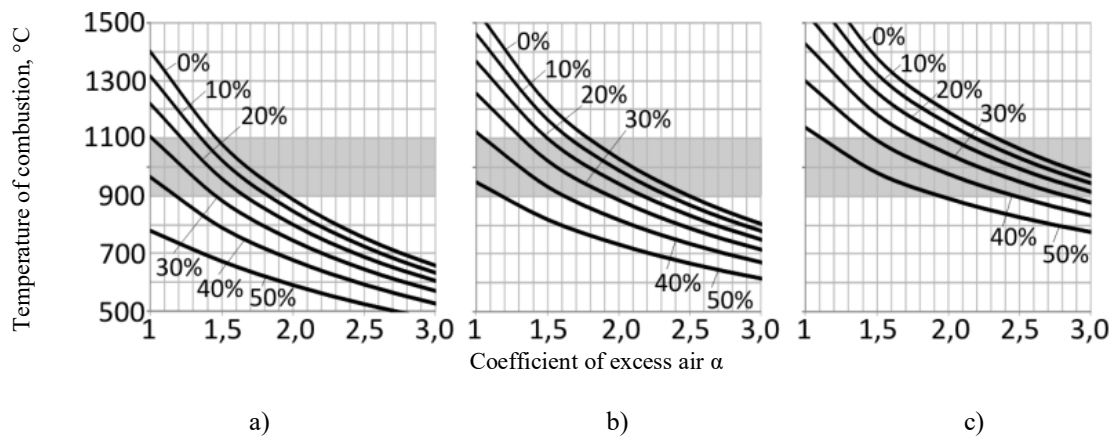


Figure 1. The combustion temperature for different humidity of solid waste and the temperature of the air supplied for combustion: a) 20 ° C; b) 200 ° C; c) 400 ° C

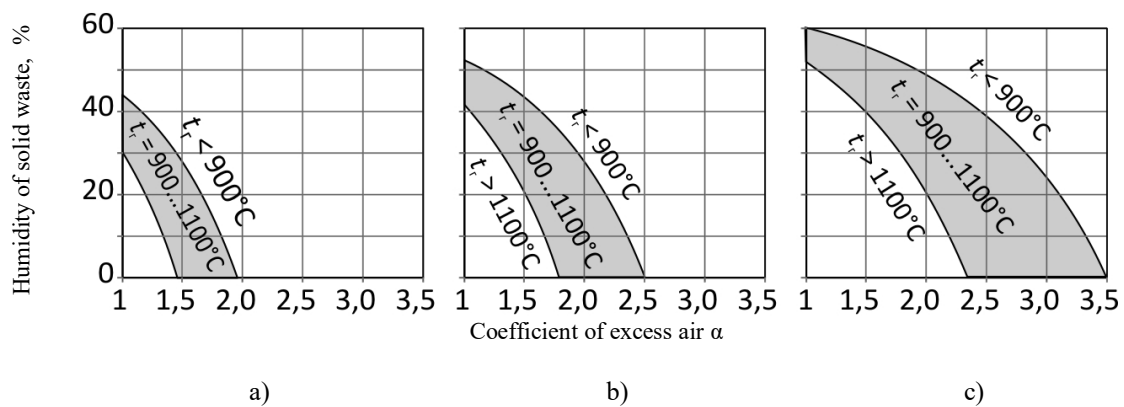


Figure 2. Isotherms of the combustion temperature of solid waste at the temperature of the air supplied for combustion: a) 20 ° C; b) 200 ° C; c) 400 ° C

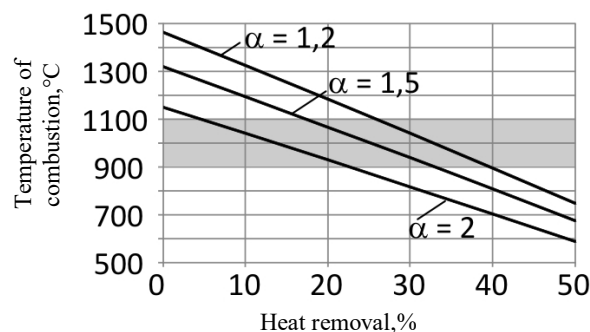


Figure 3. Change in the combustion temperature in the boiler for different heat removal (heat removal)

The obtained data are consistent with the results of the boiler tests during incineration, in which the pyrometer measured the temperature of the fuel layer in the boiler (t_g), and the gas analyzer - the composition and temperature of the gas (t_g) after the boiler (Fig. 4). The boiler output was about 50 kW, or about 25% of the heat removal.

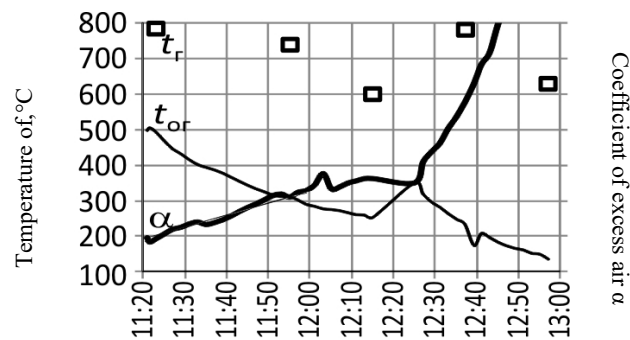


Figure 4. The data of the measurements of the combustion temperature t , the gases leaving the furnace and the heat of the excess air with a heat dissipation in the boiler of about 25%

Thus, despite the relatively high combustion temperature, the temperature of the exhaust gases is far below the values determined by environmental requirements. Although the measurements of the off-gas composition given in [8] showed no exceeding of the MPC for the analyzed gases, but according to the results of the tests it can be concluded that the environmental requirements call for the required combustion regimes in the boiler in the absence of heat extraction for heating the water.

To conclude it should be said that when MSW is incinerated, the necessary temperatures can be obtained that ensure complete combustion of harmful substances, with a wide range of regime parameters and humidity. But selection of heat in the boiler leads to a significant decrease in the combustion temperature. Therefore, in boilers for burning low-power MSW, it is necessary to constructively separate the combustion zone and the heat extraction. Taking into account the requirements for the presence of combustion products for at least 2 s at a temperature of at least 850 °C, the furnace and the heat exchanger must be separated by a gas flue of the required size.

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